

STUDY OF MORPHOLOGICAL VARIATIONS OF 50 PLACENTAE WITH UMBILICAL CORDS AND ITS DEVELOPMENTAL RELEVANCE

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ABSTRACT

Introduction: The word "Placenta" is a Latin word and the Greek equivalent word is "Plakons" which means "Flat cake on a plate". The placenta is a complex multifunctional organ. It provides nutrition, gas exchange, waste removal, endocrine function and immune support. Placenta is a special circulating system to the developing foetus. Being an organ of vital importance for continuation of pregnancy and foetal nutrition it has evolved great interest among the anatomists, embryologists, pathologists and obstetricians.

Materials and Methods: The study was done in 50 placentae which were collected from the department of Obstetrics and Gynaecology in collaboration with the department of Anatomy, Kamineni Institute of Medical Sciences, Narketpally, Nalgonda, Telangana, during the period of 2 years. The morphological variations of placenta, the size, shape, weight and attachment of umbilical cord with its blood vessels were observed, recorded and photographed. The prime objective of the study is to compare and evaluate the morphological alterations of placenta and umbilical cord in pregnancy.

Results and Conclusion: In the current study, the majority of the placentae showed round shape, few placentae with oval and irregular and with an accessory lobe in single placenta. The current study also includes variations in insertion of umbilical cords was eccentric in majority, central, marginal and velamentous in a few. Pregnancy induced hypertension significantly affects the placenta by reducing weight and it does not have any significant effect on the shape of placenta, umbilical cord insertion and number of cotyledons on maternal surface. The placenta is the most accurate record of the infants prenatal experience.

KEY WORDS: Placenta, Umbilical cord, morphometry, variations, umbilical vessels.

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INTRODUCTION

The placenta is a complex multifunctional organ of mainly foetal origin with pleiotropic roles during foetal growth. It has a foetal portion formed by chorionic frondosum of trophoblast derived from the developing

embryo. The maternal portion formed by decidua basalis derived from the modification of uterine lining of the mother [1]. The placenta uses about 1/3rd of all the oxygen and glucose supplied to the maternal blood and rate of protein synthesis is higher in the placenta than the liver [2].

The placenta is the most accurate record of the infants prenatal experience [3]. Maternal surface is divided into cotyledons with irregular grooves in between. The foetal surface is smooth, shiny, translucent and covered with amniotic membrane [4].

The expelled placenta is a flattened discoidal mass with an approximately circular or oval outline. It has an average volume of 500ml (range 200 – 950ml), an average weight of 470gms (range 200-800gms), an average diameter of 185mm (range 150-200mm), an average thickness of 23mm (range 10 – 40mm), and an average surface area of c.30,000mm². Thickest at its center and rapidly thins towards its periphery where it continues as the chorion leave [5].

The placenta is usually regarded as a foetal organ. It is a vital organ for maintaining pregnancy and promoting normal foetal development. It represents the co-operation of two distinct individuals to form single structure that protects one and enables the genes of the other to live on [6].

The umbilical cord connects the foetus with the foetal surface of placenta. A fully developed umbilical cord is approximately 1-2cms in diameter and average of 50-60cms long at full term. Its length varies from 20-120cms. It is tortuous causing false knots. Normally umbilical cord contains two arteries and one vein surrounded by Wharton's jelly, all enclosed in a layer of amnion. The cord deserves attention right from the first trimester. The umbilical cord normally inserts to the central. Abnormalities in the development, site of insertion of umbilical cord and presence of single umbilical artery can cause babies with cardiac and vascular defects [7].

Present study has been undertaken to record the data on the morphology of placenta and umbilical cord and correlate the findings with review of literature.

MATERIALS AND METHODS

The study is prospective, observational and descriptive. The study was done in 50 placentae which were collected from the department of Obstetrics and Gynecology in collaboration with the department of Anatomy, Kamineni Institute

of Medical Sciences, Narketpally, Nalgonda, Telangana, during the period of 2 years.

The placenta with attached membranes and umbilical cords were collected soon after the delivery. The placentae were squeezed to evacuate the blood and washed under running tap water. The membranes were trimmed, labeled and then it was fixed in 10% formalin. Examinations of the placentae with its umbilical cords were carried out.

Morphological study of placenta which includes: size, shape, weight and insertion of umbilical cord. Morphological study of umbilical cord which includes: length of cord, number of vessels, coiling and knotted appearance.

OBSERVATIONS

The present study included 50 placentae of normal and abnormal pregnancies / foetuses.

The observation made during the course of the present study with relevance to:

- 1) The shape of placenta, mode of umbilical cord attachment and weight of placenta.
- 2) The length and number of blood vessels in the umbilical cord.

Out of 50 placentae studied:

- 1) 39 placentae were from normal pregnancies.
- 2) 5 placentae were from hypertensive pregnancies.
- 3) 2 placentae of multiple pregnancies
- 4) 1 placenta of Acardia/ Acephalus or Trap sequence (Fig:10.a, 10.b)
- 5) 1 placenta of Omphalocele (Fig: 12)
- 6) 1 placenta of Sirenomelia (Fig: 11.a, 11.b)
- 7) 1 placenta of Anencephaly (Fig: 13)

A. 39 Placentae of Normal Pregnancies:

I. The weight of the placenta in normal pregnancies varied from 400gms to 650gms.

- 1) 14 placentae weighs below 500gms
- 2) 22 placentae weigh between 500-600gms.
- 3) 3 placentae weighs more than 600gms(Fig:6)

II. The shapes of the normal placentae studied were:

- 1) 30 placentae were round in shape. (Fig: 1)
- 2) 8 placentae were oval in shape (Fig: 12)

3) 1 placenta showed accessory lobe (Fig: 5)

III. Insertion of umbilical cord:

- 1) 21 placentae showing eccentric insertion (Fig:2)
- 2) 14 placentae showing central insertion (Fig:1)
- 3) 3 placentae showing marginal insertion (Fig:3)
- 4) 1 placenta showing Velamentous insertion (Fig: 4)

B. 5 Placentae of Hypertensive Pregnancies:

I. The weight of the placentae in:

- 1) 2 placentae weighs between 300-400gms (Fig: 7)
- 2) 3 placentae weighs between 400-500gms

II. the shape of the placentae:

- 1) 2 placentae were round in shape.
- 2) 3 placentae were oval in shape

III. Attachment of umbilical cord:

- 1) Eccentric insertion in 4 placentae.
- 2) Central insertion in 1 placenta.

C. Placentae in Multiple Pregnancies:

Out of two multiple pregnancies, one is a twin and other is triplet. (Fig: 8,9)

I. The weight of the placenta in:

- 1) Twin pregnancy 530gms (Fig: 8)
- 2) Triplet pregnancy 490gms (Fig: 9)

II. The shape of the placenta in:

- 1) Twin pregnancy – quadrangular (Fig: 8)
- 2) Triplet pregnancy – round (Fig: 9)

III. The place of attachment of umbilical cord in:

- 1) Twin pregnancy – marginal (Fig: 8)
- 2) Triplet pregnancy – central (Fig: 9)

Umbilical Cord in Normal Pregnancies:

Out of 39 umbilical cords studied from normal pregnancies:

- 1) 2 umbilical cords were between 30-40cms
 - 2) 37 umbilical cords were between 40-60cms
- All the 39 umbilical cords from normal pregnancies showed 2 umbilical arteries and 1 umbilical vein.

Umbilical Cord in Hypertensive Pregnancies:

Out of 5 umbilical cords studied from hypertensive pregnancies:

- 1) 1 umbilical cord was between 30-40cms
- 2) 4 umbilical cords were between 40-60cms

Umbilical Cord in Multiple Pregnancies:

- 1) In twin and triplet pregnancies the umbilical cords length was less than 40cms.

Abnormal Foetuses:

Morphological Variations of Placenta and Umbilical Cord in Omphalocele Foetus:

Placenta: oval placenta showing eccentric attachment of umbilical cord, weighing 500gms with retro placental haemorrhage on the maternal surface. (Fig: 12)

Umbilical cord: umbilical cord is attached to membranes of the Omphalocele of the foetus. Length of the cord was 46cms with 2 umbilical arteries and 1 umbilical vein. (Fig: 12)

Morphological Variations of Placenta and Umbilical Cord in Sirenomelia Foetus:

Placenta: placenta showing irregular shape with centrally attached umbilical cord, weighing 430gms. (Fig: 11.a)

Umbilical cord: length of the cord was 40cms with **single umbilical artery** and single umbilical vein. (Fig: 11.b)

Morphological Variations of Placenta and Umbilical Cord in Acardia/ Acephalus (Trap Sequence- Twin Reversed Arterial Perfusion):

Placenta: Round placenta showing two umbilical cords with arterio-arterial and veno-venous anastomosis, weighing 500gms. (Fig: 10.a)

Umbilical cord: Two Umbilical cords were present. The twin A (normal) cord was long and edematous, twin B had a short cord and both sharing the same Placenta. Umbilical Cords showing 2 umbilical arteries and 1 umbilical vein. (Fig: 10.a)

The umbilical arteries of twin A anastomosis with umbilical arteries of twin B. twin B receives deoxygenated blood via the umbilical arteries of the twin A. Umbilical vein of twin B leaves and anastomosis with umbilical vein of twin A. Umbilical vessels of twin B are not connected to the placental villi, on the other hand they are connected to the umbilical vessels of the twin A, which is clearly seen on the foetal surface of the placenta. (Fig: 10.a, 10.b)

Morphological Variations of Placenta and Umbilical Cord in Anencephaly Foetus (20 Weeks):

Placenta: Round placenta with centrally attached umbilical cord weighing less than 100gms. (fig: 13.a)

Umbilical cord: Lean umbilical cord with **single umbilical artery** and single umbilical vein. (fig:13.b)

Photographs of the placenta and the umbilical cord and its attachment:

Fig. 1: Placenta showing round with centrally attached umbilical cord.



Fig. 2: Placenta showing eccentric attachment of umbilical cord.



Fig. 3: Placenta showing marginal insertion (Battledore Placenta).



Fig. 4: Placenta showing velamentous attachment of umbilical cord.



Fig. 5: Placenta showing accessory lobe

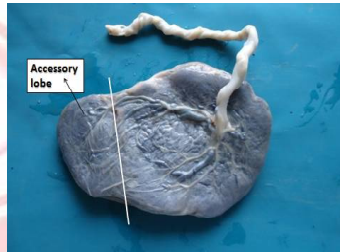


Fig. 6: Placenta showing more weight (650 gms).



Fig. 7: Hypertensive Placenta showing oval shape with less weight (300 gms)

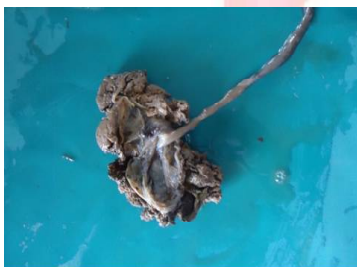


Fig. 8: Placenta of twins showing quadrangular shape with 2 umbilical cords attached to the margins.



Fig. 9: Placenta of triplet pregnancy showing round shape with 3 umbilical cords attached to the center.



Morphological variations of placenta and umbilical cord in Malformation fetuses

Fig. 10a: Placenta and umbilical cord in Trap sequence

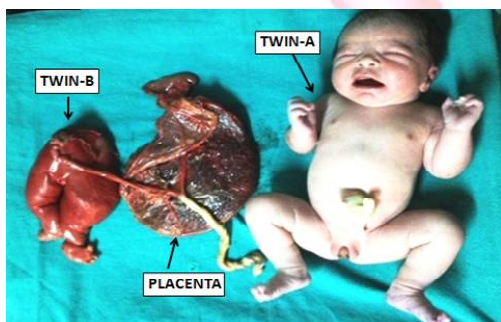


Fig. 10b: Diagrammatic representation of Arterio-arterial and veno-venous anastomosis in Acardia/Acephalus twins.

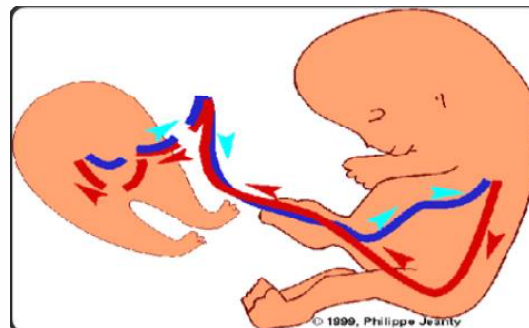


Fig. 11a: Showing sirenomelia foetal placenta with irregular shape and centrally attached umbilical cord.



Fig. 11b: Umbilical cord of sirenomelia case showing single umbilical artery and one umbilical vein.

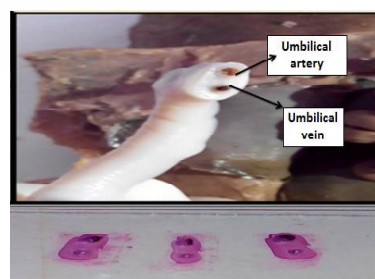


Fig. 12: Omphalocele foetus showing oval placenta with eccentric attachment of umbilical cord.



Fig. 13: Placenta and umbilical cord in anencephaly.



DISCUSSION

Placental growth occurs till 37th week. In early part of pregnancy about 800 to 1000 stem villi radiate from the entire chorionic wall. Later, with the regression of chorion leave only 60 stem villi persist in human placenta. Maternal cotyledons are 15 to 30 and each cotyledon receives 2 to 3 stem villi [8].

The foetal growth capacity is determined by placental weight. Placental weight and foetal weight will increase proportionately, with the progress of pregnancy [9].

Placenta responds to exogenous insults and tries to adapt for varying nutritional level of the mother. If this response of placenta fails to maintain foetal growth, then it results in Intra Uterine Growth Retarded babies or various congenital defects [10].

The placenta therefore serves as the major link between a mother and her unborn baby, the foetus. Owing to the delicate and important nature of the placenta it is sometimes referred to as the "mirror of the perinatal period [11]. The placenta has been described as the mirror of maternal and foetal status and its morphometric changes reflects due to maternal hypertension or diabetes and lead to IUGR or foetal malformations.

Gunapriya Raghunath, et al (2011) studied 101 placenta and found the average weight of the placenta 528.55gms in normal pregnancies and 398gms in hypertensive pregnancies, shape of placenta in majority of cases is round (93%) and oval (7%) but no accessory lobe was found. The average thickness of the placenta was 2.1cms. The average number of cotyledons on maternal surface was 18. According to them 75.45% the

insertion of umbilical cord on the placenta is central or eccentric, which was considered was normal, 16.36% were marginal, 7.27% were furcate and 0.90% were velamentous insertion [12].

The study done by Peter Kwabena Appiah (2009) in 265 placenta showed the average weight of the placenta as 563.47gms \pm 132, the average diameter of the placenta was 18.69cms \pm 2.05. The average thickness of the placenta as 2.68cms \pm 0.55. In his study, he found the site of insertion of umbilical cord on placenta is eccentric in 21.14%, central in 60.75% and marginal in 18.11% [13].

In the present study which includes 39 normal placentae, the average weight of the placenta is 513gms \pm 56.87 and in 5 hypertensive pregnancies it is 462gms \pm 38.34. In multiple pregnancies (twin and triplet) the average placental weight is 510gms. In other full term foetal anomalies (Omphalocele, Sirenomelia and Trap sequence) the weight of the placenta is around 500gms and less than 100gms in Anencephalic foetus (20weeks). In the current study the shape of placental morphometrical variations in normal and abnormal pregnancies were 70% round, 24% oval, 4% irregular and 1 placenta had accessory lobe which makes 2%. The current study also includes the variations in insertion of umbilical cords were eccentric in 54%, central in 38%, marginal in 6% and velamentous in 2%. These umbilical insertions were observed in normal placentae, mothers with hypertensive placentae, in multiple pregnancies and in foetal malformations. Our study reveals that, the alteration of morphological parameters of placenta have a main role in functional requirements which is correlated

to the normal foetal growth.

Umbilical cord connects the foetus with the mother. It forms on the ventral body wall of the foetus between the pericardial bulge and external genitalia. Exceptionally short or long cords are associated with foetal problems and complication during labor. The cord usually attaches midway between the center and the margin of the placenta. The umbilical cord insertion to the placenta shows number of variations. It can be central, eccentric, marginal or velamentous insertion. An extremely long cord may encircle the neck of the foetus usually without increase risk where as a short one may cause difficulties during delivery by pulling placenta from its attachment in the uterus [5,7].

The lean umbilical cords were observed in hypertensive pregnancy by ultra sonographic study. But no significant changes have been observed in umbilical cord dimensions [9].

Peter Kwabena Appiah during his study, he found the occurrence of 2, 3, 4 vessel cords were 1.13%, 95.85% and 2.64% respectively, indicating that the large majority of cords has 3 umbilical cord vessels (2 arteries and 1 vein) and 0.38% showed single umbilical artery [13].

Sinan Karadeniz et al. studied 259 placentae and umbilical cords, in most of the cases, there were two umbilical arteries and one umbilical vein. In two cases (0.8%), the artery was single. In the two-vessel cord, the blood flow to the placenta is only through the single umbilical artery resulting in a compensatory increase of the arterial diameter [14].

If only one artery and one vein are grossly visible, the fetal anomaly rate is nearly 50 percent. These anomalies may affect the cardiovascular, genitourinary or gastrointestinal system and others as well [15].

About 1% of singleton and about 5% of multiple pregnancies (twins, triplets or more) have an umbilical cord that contains only two blood vessels, instead of the normal three. The cause of this single umbilical artery abnormality is unknown. Studies suggest that babies with single umbilical artery have an increased risk for birth defects, including heart, central nervous system and urinary tract defects and chromosomal abnormalities [16].

By the fourth gestational week, 3 pairs of vessels are connected to sinus venosus of foetal heart. By the sixth week, a critical anastomosis occurs between the left umbilical vein and the hepatic sinusoids. At the same time, the right umbilical vein involutes. Failure of this normal process results in the extremely rare situation of a persistent right umbilical vein. Persistence of the right umbilical vein results in a 4 vessel umbilical cord (2 veins and 2 arteries) Prenatal sonographic observation of multi vessel umbilical cord is commonly seen in conjoint twins but also sometimes seen in healthy neonate without any congenital abnormalities. A 4 to 6 vessel cord has been previously reported with conjoined twins [17].

Several combinations of vessels can give the appearance of 4 vessel cords. It can be 2 veins and 2 arteries or one vein and 3 arteries. Four vessels cord result from the persistence of the right umbilical vein i.e. 2 arteries and 2 veins. Some reports suggest an increase in congenital anomalies (such as ectopia cordis, atrial septal defect, symmetrical bifid liver, cleft lip and palate, arteriovenous fistulas of the placenta) while others do not [18].

In case of one vein and 3 arteries which is another common cause (5%), the fourth vessel is the persistence of small vitelline arteries. These rarely exceed 0.5mm in diameter. These extra vessels follow the normal twisting of the main umbilical arteries. So that the cords contain 3 arteries (4 vessel cord) or 4 arteries (5 vessel cord). These vessels run for the whole length of the cord and no congenital anomaly was observed [19]. The umbilical cord length normally varies from 24 to 124 cm. In Maximum cases the umbilical cord length between 51 and 60cms. Cord length did not vary according to the weight, length, and sex of the baby. The incidence of all types of cord complications was associated with intrauterine problem. As the number of loops in a nuchal cord (cord around the neck) increases to more than two loops, it is the indication for operative procedure. The incidence of birth asphyxia, cord entanglement or cord prolapse was significantly more in long cords (>100cms) and placental abruption in short cords (<25cms) as compared to cords with normal cord length [20].

Peter Kwabena Appiah (2009), studied 265 umbilical cords and reported the average length of the cord as 44.8cms \pm 12.0 [13]. And the study done by Gupta. S, et al reported the average length of the cord as 44.3cms \pm 9.2 [21]. The length of the umbilical cord varies from 40-60cms and shows a twist of coiling. This coiling provides greater strength and necessary flexibility. This coiling arises because the longer umbilical vein twists around the umbilical arteries and provides strength and necessary to the umbilical vessels [21].

Principle clinical correlations found in over coiled cords may lead to foetal demise, intrauterine growth retardation, thrombosis of chorionic vessels, umbilical veins and cord stenosis [11].

The umbilical cord can become knotted. If the knot is loose, fetal circulation is maintained. If the knot is tightened during the foetal descent through the birth canal, can occlude the placental circulation and lead to intrauterine death of the foetus [20].

In our study, noticeably, we found that umbilical cord had 2 arteries and 1 vein in 48 specimens which includes 39 normal pregnancies, 5 hypertensive pregnancies and in 2 multiple pregnancies. The umbilical cord of omphalocele foetus had normal 3 vessel cord (2 arteries and 1 vein) attached to the amniotic membrane covering the omphalocele at the foetal end. In case of Trap sequence the anastomosis between umbilical vessels were observed between twin A (pump) and twin B. The single umbilical artery and single umbilical vein were observed only in 2 umbilical cords i.e. sirenomelia and Anencephalic foetuses (fig: 11.a, 13)

The present study was done on 50 umbilical cords, the maximum number of cases had normal cord length. The length of umbilical cord in 49 specimens was between 40 to 60cms and one specimen with Acardia / Acephalus twin B had lean umbilical cord of length less than 20cms.

Our study finally reports that the coiling and knotted appearance of umbilical cord were within the normal limits in 50 specimens studied.

CONCLUSION

The placenta is a mirror which reflects the intrauterine status of the Foetus. Critical

examination of the placenta and umbilical cord immediately after delivery should be used to determine the well-being of the baby.

The morphometric parameters were done in 50 placentae along with its umbilical cord of normal pregnancies and abnormal pregnancies which also includes twins, hypertensive pregnancies and foetal anomalies. The specimens were collected from patients delivered at KIMS Hospital, Narketpally.

In this study we aimed to investigate the morphometric characteristics of human placenta and umbilical cord. The placental study includes the weight, shape and attachment of umbilical cord in both normal and abnormal specimens. Similarly umbilical cord was studied in detail regarding its length, number of umbilical vessels, coiling and knotted appearance.

In an ocean of literature regarding placenta and umbilical cord, we authors here by contribute for a small component which may be useful to Anatomists, Embryologists and Gynaecologists.

Conflicts of Interests: None

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